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Living With Earthquake and Flood Hazards in Jammu and Kashmir, NW Himalaya

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Jammu and Kashmir is one of the most politically challenged regions in NW Himalaya, and perhaps also one of the most unfortunate portions of the planet Earth where political and natural disasters have greatly devastated the progressive development of the region. The geological past of this region suggests that it was formed when Indian tectonic plate collided with the Eurasian plate, and this also developed some intermontane basins, which house most of the population of the region. As the tectonics is still actively shaping the topography, geology, geomorphology, and climate of the region, the occurrence of earthquakes and floods in the area is potentially unavoidable. Our knowledge about the causes of earthquakes tells us that it is time to put more emphasis on preparedness rather than on the prediction, which is partly true of flood hazards as well. This paper aims to highlight the urgent need to educate local students and community leaders about the science of earthquakes, and floods, and how to live with such hazards in Jammu and Kashmir. This is backed by the field evidence where interactions will locals suggest an urgent need of comprehensive planning to educate, engage, and train local students about the science of earthquake and flood hazards. The entire population of Jammu and Kashmir is >12 million, and the vulnerability to hazards is unavoidable unless a robust framework is planned for the region. Our fieldwork clearly shows that Kashmir conflict, which is more than 71 years old political problem, has a negative impact on the mindset of people because they take earthquake and flood hazards as of secondary importance than the resolution of the political issue. Therefore, we conclude that scientific work related to hazards is highly required to educate local people by organizing a series of workshops, training sessions, course modules, international conferences, public talks, together with the dissemination of awareness about adopting earthquake resistant construction model. However, such efforts will only be effective on the ground if the political problem is resolved. Hence India and Pakistan ought to sit on the table and address the long-standing Kashmir problem for the safety and security of everyone in the region.

Keywords: Kashmir basin, Leh basin, earthquakes, floods, Kashmir conflict

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INTRODUCTION

The Jammu and Kashmir region is located in NW Himalaya (**Figure 1**) and its geology, geomorphology, and structures preserve evidence of collisional tectonics that involved India and Asia (Burbank and Johnson, 1983; Yin, 2006; Shah, 2013, 2016; Gavillot et al., 2016). During the northward journey of greater India, the plate velocity dramatically decreased from 15 to 4 cm/year at 50 and 35 Ma. And this change corresponds with the jamming of India against Asia, which resulted in the formation of the Himalayas and the Tibetan plateau (Copley et al., 2010). Although the exact timing of the collision remains a subject of debate, and for obvious reasons (e.g., Ding et al., 2005) still the popular consensus places the initial timing of collision somewhere between 55 and 52 Ma (Searle et al., 1997; Ding et al., 2005). The aftermath of collision is mainly represented by large-scale faults and folds (Gavillot et al., 2016; Shah, 2016), and some of these faults are still actively participating in the ongoing collisional deformation, and therefore occasionally medium to large magnitude earthquakes occur in the region (Burbank and Johnson, 1983; Ambraseys and Bilham, 2000, 2011; Yin, 2006). Since the region owes its existence to collision hence the occurrence of earthquake events is part of the tectonic evolution of the Himalaya and shall continue in the future. Some of the past earthquake events have unfortunately caused significant loss of life and property and these are: the 2015 Nepal earthquake (Mw = 7.9), the 2005 Kashmir earthquake (Mw = 7.6), the 1950 Assam earthquake (Mw = 8.4), the 1934 Bihar-Nepal earthquake (Mw = 8.1), the 1905 Kangra earthquake (Mw = 7.7), and the 1879 Shillong earthquake of Mw = 8.1 (Nakata, 1989; Kumar et al., 2001; Ambraseys and Douglas, 2004; Naseer et al., 2010; Avouac et al., 2015; Shah, 2016). The repercussion of collisional deformation is also the reason for the formation of some intermontane basins (Burbank and Johnson, 1982; Yin, 2006), which house most of the population in Jammu and Kashmir (**Figure 1**). The beautiful Kashmir basin is one of the several examples of intermontane basins that are formed during the period of collisional orogeny, and have undergone structural and geomorphic modifications to accommodate the ongoing tectonic convergence (Burbank and Johnson, 1982; Shah, 2013). The Kashmir and Leh basins are two examples of intermontane basins that reflect the contribution of tectonic and climatic conditions that led to their formation (e.g., Burbank and Johnson, 1982). Both basins are filled with unconsolidated fluvial, lacustrine, and glacial sediments that are now exposed as ridges and valleys. Since the basins are carved out of mountains, therefore, the geographic location is also vulnerable to flood hazards. Historical data show that floods in Jammu and Kashmir are usually caused by excess precipitation, and some events are associated with earthquakes and landslides (e.g., Lawrence, 1895; Bilham et al., 2010; Bilham and Bali, 2014; Meraj et al., 2015; Shah, 2015).

Therefore, the vulnerability of Jammu and Kashmir to earthquake and flood hazards is now well established (e.g., Bilham et al., 2010; Schiffman et al., 2013; Shah, 2013, 2015; Bilham and Bali, 2014; Meraj et al., 2015; Shah and Malik, 2017; Chandra et al., 2018; Romshoo et al., 2018), and the historical records go back to at least 1100 BC or earlier (Lawrence, 1895; Shah, 2016). This suggests that data and scientific wisdom about these hazards existed but without a proper roadmap of planning and action. The present situation on the ground is even worst. Therefore, this contribution aims to initiate a discussion on the fundamental question of why robust planning to handle earthquake and flood hazards on the ground is missing in Jammu and Kashmir, and what has stopped administrative and local people from achieving the goal of becoming a resilient society to fight these hazards. It also highlights the urgent need for awareness, preparedness, and scientifically sound education in winning the war on earthquake and flood hazards. This is particularly important because the understanding of earthquake sciences (e.g., occurrences, causes, and what controls the regional distribution, etc.) has grown in both quantity and quality but the prediction has not reached so far, and for understandable reasons (Hough, 2010). Therefore, earthquake forecasting is now more popular in the earthquake science domain (Hough, 2010; Shah et al., 2018) because it is scientifically more accurate and vigorously researched. Since the prediction of a future earthquake event is difficult and challenging, therefore, more weight should be given to various types of outreach activities, which will remain one of the most important steps to educate people on how to live with earthquakes (e.g., Paton et al., 2010; Shah et al., 2018). Same is true to flood hazards, which can be efficiently managed if proper scientific framework and education are implemented. Unfortunately, Jammu and Kashmir region has a long history of severe political problems which dates back to pre and post-independence of British India (Shah, 2016; Gilmartin, 1998). Therefore, here we will also try to understand the role of political conflicts in developing of a robust scientific and administrative framework to achieve full control over the reduction of the impact of earthquake and flood hazards.

TECTONIC AND GEOLOGICAL FRAMEWORK

Tectonics largely control the topography and geology of Jammu and Kashmir region (**Figure 1**), and it preserves evidence of pre and post-collisional histrionics of India and Eurasia tectonic plates, which are still actively contributing toward the overall development of the region (Le Fort, 1975; Burbank and Johnson, 1982). Therefore, the tales of past geological and tectonic events are preserved in rocks, sediments, landforms, and drainage. For example, the topographic and geomorphic expression of Leh valley is dominantly shaped by one major river, the Indus River (**Figure 2**) that originates at Mount Kailash in Tibet, and flows westward through the regions of Jammu and Kashmir until it reaches Pakistan. The river exposes deep gorges and incised valleys filled with a variety of fluvial, lacustrine, and glacial deposits, which are underlain by rock units of varying age. Broadly the northeastern portions of the river valley are comprised of the omnipresent Ladakh Batholith, which is the significant landforms that greets when one lands in Leh. The lack of vegetation at high altitude in cold arid climate exposes the barren, and rusty look of the batholith, which exposes rock outcrops, almost, wherever you go. The batholith is part of the

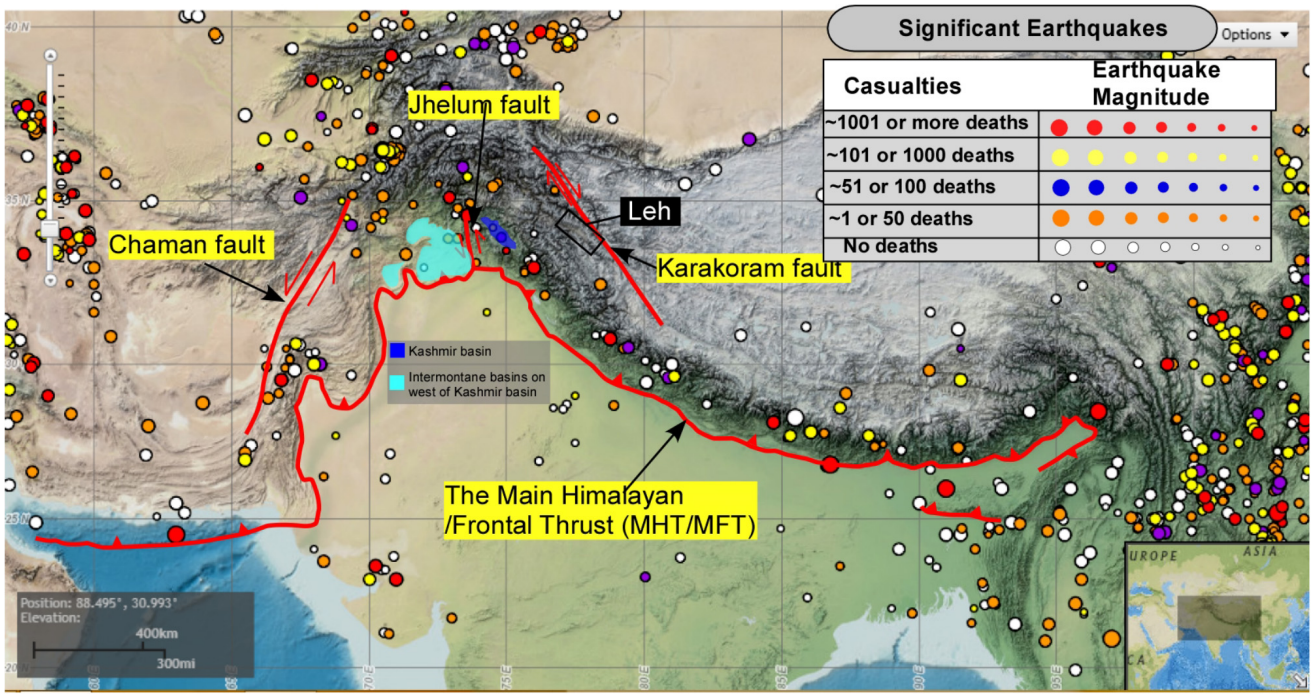

FIGURE 1 | Shows the distribution of significant earthquakes (as colored dots) and the associated casualties (color indicates the number of deaths) on the satellite image of the Himalayas. The Leh and Kashmir basin are shown as colored polygons. The major active faults are highlighted in red lines. The figure is prepared from the freely available data on NOAA's Natural Hazard Viewer. It is retrieved on 20th July 2018 from NOAA National Centers for Environmental Information at: https://maps.ngdc.noaa.gov/viewers/hazards/?layers=2&extent=-180,70,180,-70.

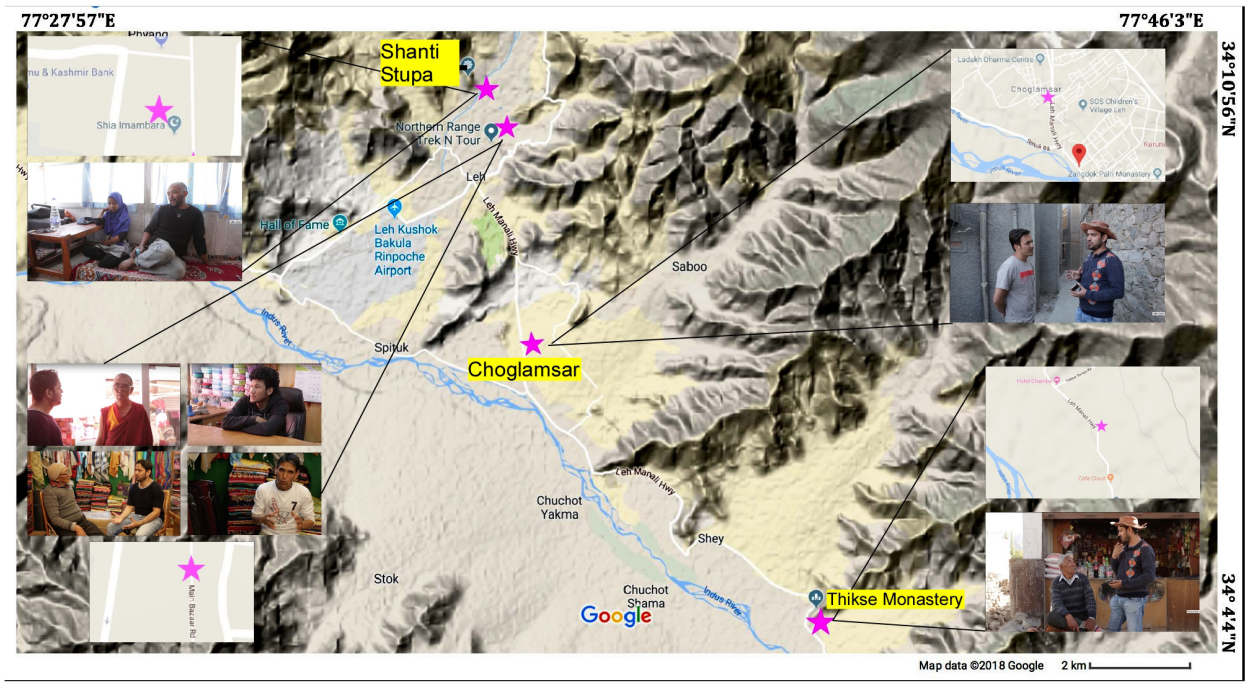

FIGURE 2 | The Google terrain image shows the location of field interaction with locals in Leh. The satellite image is retrieved from Google maps on 20th July 2018. A written consent form is signed by each participant that is interviewed during the fieldwork in Jammu and Kashmir (a few examples are shown here).

Transhimalayan Batholith systems, which have intruded at ∼47–70 Ma ago in a tectonic arc setting from 7 to 15 km depth, and the emplacement possibly ended soon after the India-Asia collision at ∼50.5 Ma (Najman et al., 2010; St-Onge et al., 2010; Kirstein, 2011). Throughout Leh, these batholiths are exposed mainly on the right bank of the Indus River while as the left bank is delineated by slightly metamorphosed and deformed sequence of limestone, mudstone, and conglomerate. The valley roughly follows the Indus-Tsangpo Suture zone (**Figure 1**) that demarcates the major boundary of the Indian and Asia plates (Wallis et al., 2016).

Kashmir basin is an example of intermontane basins in NW Himalaya, and it has formed recently at ∼4 Ma ago (Burbank and Johnson, 1982, 1983) at the last stage of India and Asia collision. The presence of the basin within the rising Himalayan mountains ornamented with lush green forests (often with pine trees) makes this basin one of the most beautiful places on the planet Earth. The earthquake and flood disasters have continuously occurred throughout its geological history, and are still posing a significant threat (Lawrence, 1895; Shah, 2013; Meraj et al., 2015). However, while dealing with these hazards we ought to understand a positive aspect of earthquakes that have primarily shaped this region and, therefore, it is crucial that we start to give credit to these events for developing the landscape of Kashmir the way it is now, and we must avoid creating a sense of fear in people to hate earthquakes. It is imperative to sense that earthquakes have primarily contributed to shaping the land that we call home. This becomes obvious when we study rocks, which are mostly marine sedimentary rocks that have formed in an oceanic setting, and are subsequently deformed, and faulted during the collision of India with Asia. These rocks are mostly composed of Triassic limestone units, which have been intruded by Panjal volcanic series. This rock sequence is now overlain by a thick blanket of Holocene to Recent sediments that are mainly formed in fluvial, glacial, and lacustrine environments (Bhatt, 1976; Burbank and Johnson, 1982) and is sourced from the nearby mountains that have risen during the India-Asia collision and are still actively rising. Currently, the Main Himalayan thrust fault is the major earthquake causing fault system onto which the Jammu and Kashmir region is riding (Shah, 2013, 2016). Most of the population in Kashmir reside on these sediments, which are also pierced by one major active fault known as Balapur fault/Kashmir basin fault (Shah, 2013). These sediments are highly prone to liquefaction, which can make monsters out of an ordinary earthquake (Shah et al., 2018). A number of earthquakes are reported to have hit this region in the past (Lawrence, 1895; Bilham et al., 2010; Shah, 2013; Bilham and Bali, 2014), and in the near future a possibility of a major earthquake to hit this region is unavoidable (Shah, 2013). Flood disasters have also devastated the economic condition of this region, and such events have a long history (e.g., Lawrence, 1895; Bilham et al., 2010; Bilham and Bali, 2014). The September 2014 flooding devastated most of the Kashmir valley and turned it into a large pool of water, and the dominant inundation occurred in NE portions of the valley, which are tectonically subsided as the basin rides on fault ramps (Shah, 2016). Flooding mainly occurred along in and around the Jhelum River and some of its tributaries (Meraj et al., 2015).

METHODOLOGY

The purpose of this work is to map and understand the level of earthquake and flood hazard related scientific awareness in parts of Jammu and Kashmir, NW Himalaya (**Figure 1**). Therefore, it involves standard pre- and post-fieldwork exercises where initially literature review is used as a guide to make a base of what has been achieved with regards to education and awareness about these hazards. For this study, the geological and historical background of the region is mainly located in the primary and secondary sources. The primary sources comprise the fieldwork via interaction with locals; secondary sources include books, journal articles, and reports. The first step involves making a base map using Google maps data (**Figure 1**), which is followed by the plotting of possible fieldwork locations on it. The fieldwork is mainly conducted in Leh (**Figure 1**) where we covered the entire extent of the valley so that it is possible to interact with a range of people distributed across and along the whole stretch of the valley (**Figure 2**). We targeted people in the age group of 18 years and above so that a variety of subjects are analyzed, and in the end, we recorded interviews of 14 people, who have provided a written and informed consent for this (**Figure 2**). The typical interaction session followed the questions as listed in **Table 1**. The planning to visit the selected places in Kashmir valley did not work because during our field session the region was immersed in violent political conflict-related issues, and therefore, only a few nearby places in Anantnag town are visited (example in **Figure 4**). No interviews are recorded because of political instability in the region and for security reasons.

RESULTS AND INTERPRETATIONS

Fieldwork in Leh

The geological fieldwork in Leh is part of our ongoing scientific mission that involves two lenses of investigation. The first lens mainly focuses on the mapping and understanding of the geological and tectonic origin of Leh basin, which is an intermontane basin similar to Kashmir basin but much smaller in extent (**Figure 1**). This has significant implication for the occurrence of future earthquakes and floods in the region. The second investigative lens emphasizes the status of scientific outreach activities in the area, and to know the current knowledge of awareness about the earthquake and flood-related hazards in Leh. Below is the summary of our field session:

The fieldwork started in June 2018, and our team surveyed the entire extent of Leh basin (**Figure 1**), which stretches roughly parallel to the Indus-Tsangpo Suture zone that delineates the major boundary of the India and Asia lithospheric plates (Wallis et al., 2016). The one to one interactive sessions with locals is designed to map and understand the level of scientific knowledge about the earthquake and flood hazards. Therefore, a variety of subjects are approached, that mainly comprise of students, traders, and government officials. The typical questions asked are listed in **Table 1**. Most of the people that we contacted for our research interactions were very friendly and easy to talk. However, we did find some who were not willing to participate,

TABLE 1 | The typical questions and answer session with participants.

No.	Typical questions	Typical answers
1.	What is the most popular story that you know about the formation of Leh valley.	It was a large lake, and later God/saint reclaimed it by draining off the water from the lake.
2.	Tell us about the earthquake hazards in Leh.	We don't have earthquake hazards here. However, sometimes small magnitude quakes do occur.
3.	Have you experienced or heard about any earthquake occurrence in the Leh region?	No, we heard nothing about past earthquakes from our elders and other media.
4.	What will you do if an earthquake occurs?	I don't know. We are told there is absolutely no earthquake threat in the region. Leh is a sacred place. Nothing untoward will happy except by the permission of God.
5.	Have you experienced, in your lifetime, floods in Leh?	Yes, the memories of 2010 floods are hard to erase. It is the worst example of flash flood that we have experienced in Leh during our lifetime.
6.	Do you know what to do before, during and after floods?	We are not specially trained for this; we react instinctively to the situation. In the 2010 flood, we rushed from the flood-ridden river area to save life and property. But this was not a coordinated and well-managed exercise, and many people lost their lives to the devastating floodwaters.
7.	Why people are still building houses in the high flood risk zones.	Because we do not know where to build. There are no regulations on that, and often the less flood risk regions are expensive to buy. Relocation is costly and unaffordable.
8.	Have you read or listened to anything about earthquake and flood hazards in Leh via books, newspapers, Television, magazines, etc.?	I have heard about floods but not about earthquakes. There are no specific and scientifically sound programs to train or educate us about these hazards.
9.	Do you think the government should give more education and research scholarships to people in Jammu and Kashmir, and especially Leh so that the people are trained to face these natural hazards?	Yes, the quality of education together with the overall economic condition of people of Jammu and Kashmir has been dramatically affected by the political problem here, and therefore, encouraging education and research through scholarships will be very helpful for us.
10.	Do you think someone responsible should give you training about earthquake and flood hazards and how to live with such dangers.	Yes, I think this is a great idea, and shall help us to understand the science, and how to live with hazards.

and this was particularly witnessed when we informed them that we would like to video record this conversation for our earth science education outreach related documentary movie, which we are planning to make out of the entire field exercise in Leh. This is why we could only record 14 interviews during our 8 days of fieldwork. Before the recording of a formal conversation an informed written consent form is signed by each participant that was interviewed (a few examples are shown in **Figure 2**). The questions that we asked during the interview sessions were mainly related to the past occurrence of earthquakes and floods in the region, and the scientific information about such events through various sources like books, newspaper articles, local, or international media, etc. (see **Table 1** for details).

The majority of the participants are aware of the flood hazards in the region, and we interpret this as a result of devastation that is caused by the 2010 flash flood, which is considered as one of the most devastating floods that the region has witnessed over the decades (Hobley et al., 2012). A significant quality of river discharge accumulated after a convective storm event occurred on August 6, 2010 over the Ladakh Range, which led to an unfortunate loss of ∼600 people and devastated more than 60 villages (Hobley et al., 2012). Several eyewitness accounts confirm that the flooding occurred at about 11 p.m. when most of the people were asleep, and that could be one of the primary reasons for a high number of casualties (**Figure 2**). However, the locals informed us that the number of casualties are somewhere between 200 and 300 and not 600 as reported earlier (Hobley et al., 2012). Some recent works also indicate the number below 300 (e.g., Thayyen et al., 2013). The Google satellite imagery captured before and after the flood shows the extent of devastation in Choglamsar region, which is considered as one of the most badly affected regions in Leh (**Figure 3**). Previous studies have shown that the origin of flash flood is Saboo catchment area (**Figure 2**). This later collected water and debris in the downstream direction and destroyed various property, and resulted in an unfortunate loss of 145 people (Thayyen et al., 2013) in the catchment region, and most of the flood impact is witnessed in the Choglamsar area, which is located at the termination of the catchment. The scare caused by the flood has no effect on the ground because people have started rebuilding houses in the highly vulnerable valleys, which are prone to floods. Some new buildings are erected over the same sites which were previously destroyed in the 2010 flood. This is alarming because such regions are highly vulnerable to the devastating quantity of debris flows, which can wash away such structures easily. And when we asked local people why they rebuild and build houses at these highly risky flood zones, they said they are left with no other choice. They can't move as it entails buying new land in safer places, which is not affordable. And also there is no clear guideline from the authorities on where to build and where not to build. Since Buddhist beliefs mainly dominate the population in Leh, during our interaction most people confessed that it was due to his holiness, Mr. Dalai Lama, the Tibetan spiritual leader that their families were saved during the floods. Mr. Lama has no direct role to control or mitigate floods, but his followers attribute life and death to him. It is essential to understand how religious

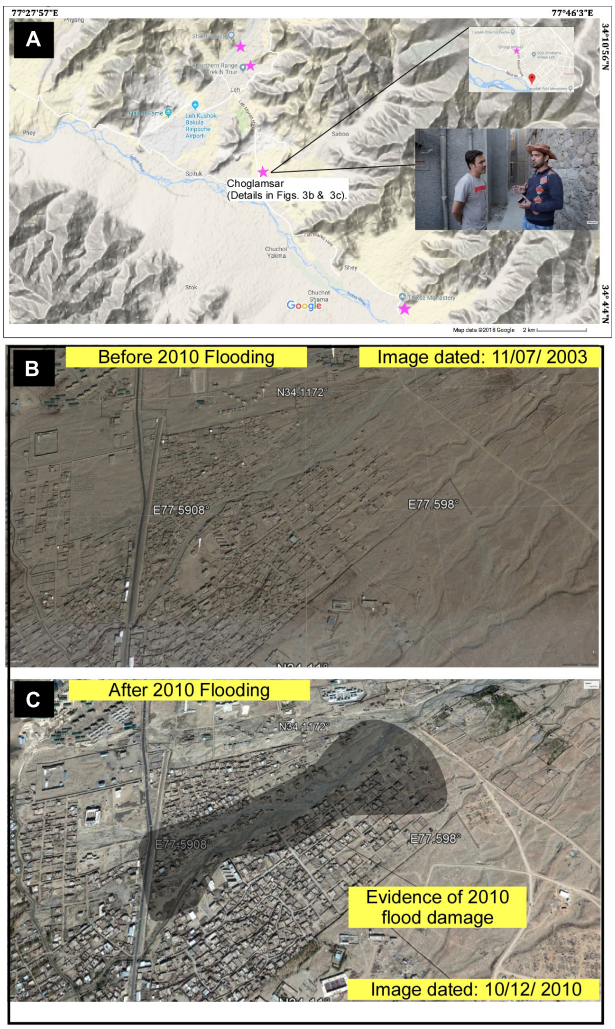

FIGURE 3 | The Google terrain image **(A)** shows the location of Choglamsar area that was badly impacted by the 2010 flooding. **(B)** The Google satellite image before 2010 flood and panel **(C)** is the image after the 2010 flooding. The extent of devastation is visible (highlights in polygon). The first figure **(A)** is obtained from Google maps on 20th July 2018, and subsequent figures **(B,C)** are also acquired on the same date from Google Earth that uses images from Digital Globe.

beliefs can influence understanding and how people perceive hazards. A similar story is witnessed in Kashmir (see the Kashmir section below).

Another important information about community vulnerability came to light when we were told by one of the Tibetan refugees who lost his home in the 2010 flood that most of his community members live in Choglamsar area (**Figure 3**), which was severely hit during the flood. The Indian government gives the land to Tibetan refugees, and they cannot move to another place because they are not the citizens of India! This needs further work as the subject has highlighted administrative failure to safeguard refugees.

People in Leh are not worried about earthquake hazards and are mostly unaware of the science of earthquakes, and if the region is at risk or not. The locals informed us that they do not know about any past earthquake disaster in the area and have not heard any such stories from elders either. The tremors of small magnitudes do occur in the region, and one such tremor occurred while we were interviewing people in June-2018.

Fieldwork in Kashmir Basin

Kashmir basin, which is an intermontane basin, rides on active fault systems (Burbank and Johnson, 1982; Shah, 2013), and therefore, highly prone to earthquake hazards. And since the basin is carved out of rising Himalayans during the collision orogeny of India and Asia, consequently, the basin is also highly vulnerable to fluvial floods (Meraj et al., 2015; Shah, 2016), and one of the worst such flooding episodes occurred in 2014 (**Figure 4**) when most of the basin was underwater. Therefore, our motivation to do fieldwork in Kashmir is to highlight the significant issues related to earthquake and flood hazards that people are facing on the ground, and how to deal with it. However, and unfortunately, the current political condition in Kashmir valley has remained turbulent, extremely disturbed, and not suitable for fieldwork. The roots of the decades-old political unrest in Kashmir goes back to at least pre and post 1947 partition of the Indian sub-continent. British India was divided along religious lines into Hindu dominated India and Muslim dominated Pakistan (see section "Discussion" for details), and this division was based on the two nation theory that demarcated separate statehood for Hindus and Muslims of greater India (Gilmartin, 1998). Therefore, during the tenure of our project we were unable to do extensive fieldwork in Kashmir valley, and it was equally risky to conduct interview or surveys. The only locations that we visited are in the close vicinity of Anantnag town (**Figure 4**). Luckily, through some personal contacts, we were able to organize lectures on earthquake hazards in Jammu and Kashmir in two colleges in Anantnag. A large number of students (more than 100) in each college and staff attended the lecture. The most interesting part of this experience was to engage with the audience during the question and answer session. Questions, particularly from students underline a constant desire and deep quest to learn, understand, and plan for the welfare of the planet that we call home. They were very keen to know about the active faults in Kashmir region, and the tectonics that has largely shaped the geological deposits of the basin, and about the causes of earthquakes and floods in the region, and possible remedial measures to minimize the impact of such hazards in future. Unfortunately, the students are not exposed to local geological outcrops and are equally not aware of geomorphology and tectonics of the region. Our initial plan was to organize a few days of fieldwork with local students to partly fill this knowledge gap; however, because of the worsening political conditions in South Kashmir, where our team is based, we could not organize it, which is really unfortunate. The only interactions that we had largely remained confined to the institute premises. We did ask some locals about the earthquake and floods in the region and visited a few nearby sites. The locals are more worried about floods, and this is mainly because of the repetition of disastrous floods in Kashmir. Our interaction with locals clearly show that the large-scale flooding in September 2014 has instilled a strong

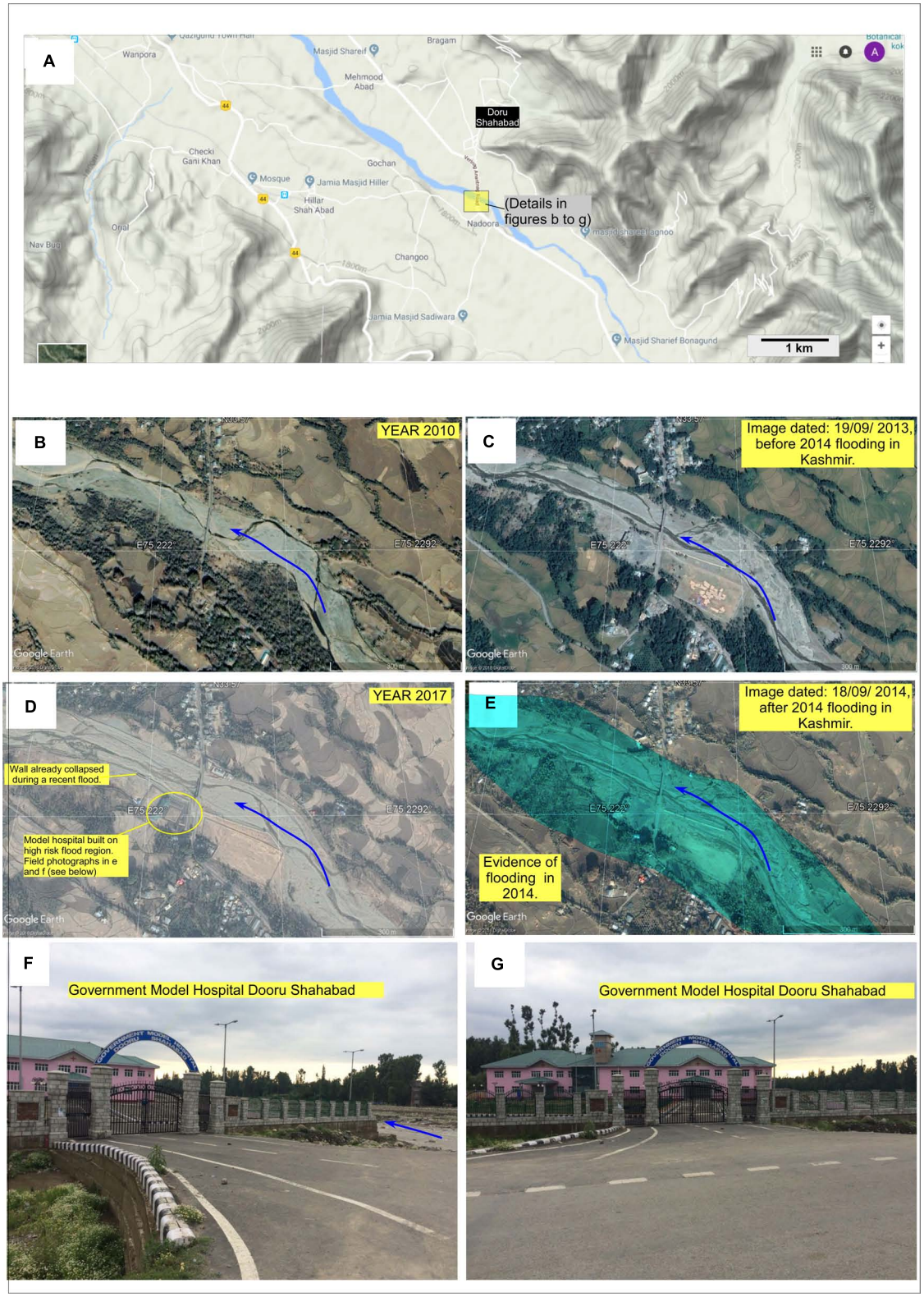

FIGURE 4 | The Google terrain image **(A)** shows the location of a newly constructed government hospital in Dooru, Anantnag, Kashmir. Subsequent figures **(B–E)** show the historical satellite images of the area and highlight the reckless attitude of authorities to build a new hospital right on the active flood plain area of the stream that was recently flooded in 2014. The field photographs of the hospital building are also shown **(F,G)**. The first figure **(A)** is obtained from Google maps on 20th July 2018, and subsequent figures **(B–E)** are also acquired on the same date from Google Earth that uses images from Digital Globe.

feeling of fear in people, and whenever it rains for a few days, the locals start to navigate possibilities of rescue and rehabilitation. They remain alert at all the times during rainy seasons, and this has more or less persisted after the 2014 flood. On the ground, there is no roadmap available for the people that would equip them to deal with the potential flood hazards. The urbanization of vulnerable and flood-prone regions has not stopped even after the 2014 flooding. This becomes evident when we look for evidence on the ground and satellite images and come to realize that the regions which were completely submerged during the 2014 flood have been occupied now (**Figure 5**). This is saddening, as it completely underestimates the safety and security of life and property. However, our interactions with people seem to suggest that there are no better choices to make because of financial hurdles that will not allow one to relocate and buy a new property at safer locations. This is one of the most important reasons that people are not thinking to relocate. They feel the worst nightmare is over, and such a disaster will only recur in a long time or possibly never. This is an example of wishful thinking, but scientifically incorrect or impractical. What amazes one is the fact that even a government model hospital has been recently built on a total flood risk region in Dooru, Anantnag (**Figure 4**). It is located on a highly vulnerable floodplain area that often gets eroded during high discharge volume in the river. The evidence of a recent such erosional downcutting is even visible from the satellite image (**Figure 4D**). Similarly, one religious structure is built on a small stream that flows through the town of Laizbal, Anantnag, Kashmir, and whenever it rains heavily for a day or two, the structure becomes inaccessible due to waterlogging. Such types of unplanned urbanization are frequent in Kashmir, and it contributes to the overall increase in flood-related destruction over the years.

The people of Kashmir are predominantly Muslims, and the popular perception is that Allah (God) is testing the erring people through various kinds of calamities, which includes earthquakes and floods. Therefore, the belief pervades that whatsoever people do to save themselves will not work unless they do not mend their life on religious lines. This is something that needs to be taken very seriously as such perceptions can contribute toward the overall development of mindset to deal with hazards (see section "Discussion" for details). The houses that we have seen and visited have no structural integrity to withstand a moment magnitude of six and above earthquakes.

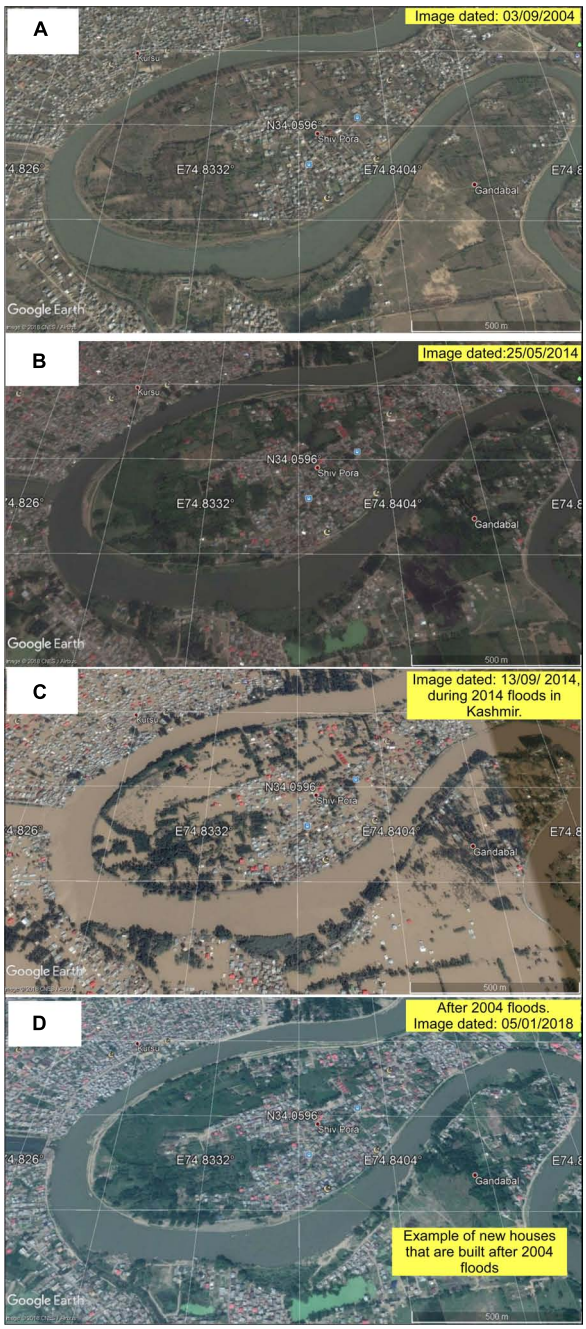

FIGURE 5 | The historical Google satellite images are shown and the urbanization is highlighted **(A–D)**. The region which was completely submerged during the September 2014 floods are now reoccupied **(C,D)**. Such practices are a routine in Jammu and Kashmir. All satellite images are obtained on 20th July 2018 from Google Earth that uses images from CNES/Airbus.

DISCUSSION

Earthquake and Flood Hazards in Jammu and Kashmir

Jammu and Kashmir region rides on active fault systems (**Figure 1**), and Himalayan frontal fault system is one of the major fault systems that can cause unprecedented destruction (Bilham et al., 2010; Shah, 2013) because the preparations to deal with future earthquake disasters have not started at the ground level (Shah, 2016). This gets even murkier because the >12 million population of Jammu and Kashmir mainly resides on the unconsolidated sediments that have filled the two major intermountain basins, the Kashmir and the Leh basins (**Figure 1**), during the period of India-Asia collision (Burbank and Johnson, 1982). These basins mainly preserve sediments that are deposited in fluvial, glacial, and lacustrine environments. Jammu and Kashmir sits on the tectonically active structural

ramp of MHT, which can lead to large-scale devastation (Shah, 2013) as a medium to massive magnitude earthquake is expected in the region. This is significantly more devastating for the intermontane basins that are often filled with unconsolidated and water-saturated sediments because medium to large magnitude earthquake can cause intense ground shaking which can lead to the severe problem of liquefaction, and past evidence of earthquakes associated with liquefaction do exist in Kashmir (Ali and Ali, 2018). New Zealand is a developed nation and has grown in the womb of active tectonic plate interactions, which are usually associated with medium to large magnitude earthquakes. Despite all of the past the efforts to improve the infrastructure for safety and security of people the nation witnessed one of the worst earthquakes in history when on February 21, 2011 a medium magnitude earthquake devastated Christchurch and caused 181 deaths. The damage to the buildings was mostly attributed to the widespread occurrence of liquefaction, which considerably worsened the problem and caused significant loss (e.g., Crowley and Elliott, 2012; Shah et al., 2018). This could give us a possible image of the scenario in Jammu and Kashmir, which has not developed any concrete strategy to safeguard people and property.

Our field experience in parts of Leh, and Kashmir basin clearly suggest that on ground the preparations are almost nil, and this is significantly worrying because of the fact that possibility of any future medium to large magnitude earthquake-related damage in this region is very high (Bilham et al., 2001; Shah, 2013). Our field interaction with local people indicates that most of the people are only concerned with the flood hazards, and we interpret this has roots in human psychological attitude toward disasters. When it hits hard, we are concerned, otherwise there seems to be no problem. Since the recurrence interval of a medium to large magnitude earthquake is often longer than a flood recurrence time, therefore, the memory of a devastation event to act often favors flood hazards. Frequent hazards work as a continuous reminder, and often such reminders are needed. Our attitude and experience validate this because routinely whenever a devastating earthquake or flood occurs, we start to research, plan, and implement a solid strategy to counter future potential disasters. We all acknowledge the deadly event of 2004 (Sieh, 2007) that led to the reinvention of tsunami research throughout the world, and in particular within the Asian regions. Similarly, when Pakistan was severely hit in the 2005 earthquake the concerned authorities started to work, but on the ground, it has to go a long, long way (Pathier et al., 2006; Shah et al., 2018). Although the "Republican Day" earthquake of January 2001 that devastated Bhuj (Gujarat) with more than 19000 casualties (Bendick et al., 2001) did awaken the sleeping Indian authorities to act, however, work on the ground is still miles away. And our work in Jammu and Kashmir solidifies such statements.

The scientific information about earthquakes and flood hazards in Jammu and Kashmir region is hugely lacking, and on the ground, most of the people are not concerned about earthquake but floods. However, the continuous construction of residential or government buildings on the high flood risk regions is seriously worrying. Unfortunately, the urbanization has spread into areas, which were submerged entirely and wholly devastated during the 2014 flooding (**Figure 5**). How can people make such choices? Lack of education and awareness is indeed one of the major contributors to this. But there are other factors, e.g., economic, social, and political conditions, which force one to stay in risky zones. This gets even murkier when earthquake risk is taken into consideration. Currently, people are not following any seismic resistant design to construct houses, etc., and the state government has not given any clear-cut direction in this regard. Hopefully, such provisions will be practiced soon. However, merely enforcing a law regarding this may not change much on the ground because the economic condition of people is not healthy, and the decades-old political unrest has dramatically damaged the economic, social, political, and scientific developments in the state. The best option to win the battle with earthquake and flood hazards in Kashmir will be to end the political unrest, which has sabotaged the mental, psychological, political, social, and scientific progress (see below). How can one think of earthquake hazards when daily life is much worst and full of misery and uncertainty?

Contribution of Kashmir Conflict in Understanding and Mitigation of Hazards in Jammu and Kashmir

Political conflicts have the potential to weaken a nation and make monsters out of ordinary hazards (Shah et al., 2018) and this often hinders any scientific effort to safeguard people. This is evident in Jammu and Kashmir, which is one of the most intense conflicts in Asia. It is very intriguing to note that this region has not developed a robust infrastructure to deal with earthquake and flood hazards when in reality this region has grown in the womb of earthquakes and floods throughout its structural, geological, and tectonic history (Lawrence, 1895; Burbank and Johnson, 1983; Shah, 2013, 2016; Meraj et al., 2015; Kumar and Acharya, 2016). The mighty Himalayas have formed after the India-Asia collision, and that also resulted in the formation of intermontane basins (Burbank and Johnson, 1982), which house most of the population in Jammu and Kashmir. The earthquake and floods have structured the land that we call home. In spite of this intrinsic relationship with hazards, we are still miles away from developing a firm policy to live with these hazards (Shah, 2016). And one of the primary reasons for not achieving this is the role of political conflicts in destroying efforts to win the battle against these natural hazards. The evidence of this is present everywhere in Jammu and Kashmir. During the fieldwork in Leh and Kashmir, we realized that political conflict had overshadowed every sphere. People talk about the resolution of the political dispute as of primary importance, and everything else is secondary (see below). This has a strong reason because it is something which significantly impacts the daily lives of people. Therefore, without addressing the political dispute, it is impossible to improve the standard of living and to deal with natural hazards.

Throughout our fieldwork, in Jammu and Kashmir, we noticed some obvious evidence of political conflict everywhere. This was particularly true and hard to miss in the Kashmir valley which is the center of this political conflict. Graffiti on the public walls

saying "We Want Freedom," "Go India Go Back," etc., greets visitors everywhere. When we talked to the locals, it became quite apparent that Kashmir conflict has carved deep and painful wounds, which are difficult to ignore. The roots of the Kashmir problem can be traced back to pre and post 1947 partition of the Indian sub-continent (Gilmartin, 1998). The separation of British India into Hindu dominated India and Muslim dominated Pakistan was achieved on the basis of religion, which has its foundation in the two nation theory that differentiates between Muslims and Hindus on the basis of religion. The religiously guided partition of British India into India and Pakistan is one of the most brutal, painful, and agonizing memories in the world because it led to mass migration, dislocation killings, and rapes (Brass, 2003).

India and Pakistan had existed as independent regions for a little over 2 months when they confronted each other in a war over the future of Jammu and Kashmir in October 1947. Before India's partition and Independence Kashmir was a princely state (Subbiah, 2004; Sherman, 2007) ruled from Jammu by the Hindu Dogras, who presided over a mostly Muslim population. It was under the leadership of Sheikh Mohammed Abdullah, who is one of the most important political figures in the modern history of Jammu and Kashmir, and his party the National Conference, that the "freedom movement in Kashmir" was launched in 1931, against the ruling Hindu Dogra monarchy (Wani, 1995). The 1930s was a period when the Kashmiri leadership consolidated this movement and began articulating its agenda in nationalist terms, "one which addressed the issues of the Kashmiri nation as a whole" (Zutshi, 2004). Imbued with socialist ideas and informed by the discourses of Kashmiriyat, the National Conference led by Sheikh Abdullah became "the bearer of the majoritarian nationalist ideology for the people of the state" (Zutshi, 2004). Sheikh Abdullah's close association with Jawaharlal Nehru and, consequently, with the Congress-led Independence movement in India (Fazili, 1980) did not have full support in the valley. As a result, the opposing political force, the Muslim Conference, which was politically close to the Muslim League, regained popularity (Zutshi, 2004). The Muslim League, led by Mohammad Ali Jinnah (Afzal, 1966; Islam, 1981), in turn, did not consider the National Conference as the representative voice of Kashmir. Jinnah is reported to have said that "99 percent of the Muslims who met me are of the opinion that the Muslim Conference alone is the representative organization of the state Muslims" after his visit to Kashmir in 1944 (Fazili, 1980). The Kisan Mazdoor Conference and the Socialist Party in Kashmir were in favor of accession to Pakistan (Fazili, 1980). One can conclude from the different accounts of the 1930s and 1940s that while Abdullah had a towering presence in the valley, other competing political opinions were being expressed during the same period on the future of Kashmir.

The political crisis in Kashmir persisted until the time of India's partition, and the political fate of Kashmir remained undecided even with the creation of India and Pakistan. A revolt against the Maharaja by his own forces was underway in certain parts of the region mainly in Poonch (popularly known as the Poonch Revolt) and Mirpur (Ellis and Khan, 1999; Ding et al., 2005), when a large number of tribesmen from the neighboring areas of NWFP (North West Frontier Province) in Pakistan invaded the Kashmir valley with the help of the Pakistani Army. Many Kashmiri Muslims also looked upon these tribal lashkars (a military force) as liberators fighting the rule of the Dogras (Whitehead, 2007). The National Conference, with its stronghold on the political sentiment in the valley, organized itself into a "militia" to defend Kashmir from this attack. As the fall of Srinagar seemed imminent in October 1947, the Maharaja signed the Instrument of accession to India. The conditions of the accession to India were that the Army would be sent to repel the attack on Kashmir and that the "finality" of the Maharaja's accession would be decided with a "reference to the people" of Jammu and Kashmir (Bose, 1997). Subsequently, the Indian Army was airlifted to Kashmir, and the tribesmen pushed back. Many questions about what happened during those 4 days remain mired in controversy. A ceasefire was announced in 1948 that brought the war to an end. It left "two-thirds" of Jammu and Kashmir under Indian control while parts of "Western Jammu and Poonch as well as Gilgit and Baltistan, fell under Pakistani control" (Bose, 1997). Historically, the 1947–48 Kashmir war is the moment when Kashmir became a "disputed part" of India and Pakistan (Jalal, 1990). Since then Kashmir has become a battleground for three competing nationalism, Indian, Pakistani and the aspirant Kashmiri nationalism. The Indian official position has been that Kashmir is an integral and fair part of India and any opposition, armed or otherwise, against the Indian rule is a handiwork of Pakistan. Pakistan, on the other hand, regards Kashmir as the "the jugular vein of Pakistan" and holds that India has occupied Muslim majority Jammu and Kashmir by pure military might which is against the underlying logic of partition. Kashmiris think that they have historically been deprived of any fair agency over their own political dispensation by two mighty and feuding nations, India and Pakistan (Whitehead, 2007). Seeking their right to self-determination, Kashmiris have tried every possible agency for the past 90 years; ballots, talks, arms, and stones. This struggle for freedom has claimed around 1,00,000 lives, thousands of children have been orphaned, thousands of women raped allegedly by Indian forces, and property worth billions of dollars gutted in anti-terrorist operations by the Indian security forces. The conflict has taken a vicious turn since July 2016 after the famous Hizbul Mujahideen insurgent group commander, Burhan Wani, a local young poster boy was killed by Indian Army. Everyday news of death, torture, injuries, cordons, young boys joining militant groups comes from the Kashmir.

God Testing Us Through Natural Disasters

The public perception about hazards has evolved over time (Alexander, 2007), and our fieldwork provides further details that cultural practices and beliefs are essential components of scientific knowledge base onto which people usually built castles of misconception, which become barriers to development and progressive approach (Tejwani and Immerman, 2008). This is also suggested by our interaction with locals in Kashmir where

they firmly believe that God punishes us via earthquake and flood hazards. This is possibly one of the primary reasons that people are not protesting against decades of administrative inaction and failure to secure people from earthquake and flood disasters. Otherwise, any feeble issues related to government failure is routinely contended through public protests in Jammu and Kashmir. Such religious perception is also observed in Leh. The popular cultural tradition in Leh also suggests that in the past the entire Leh valley was a large lake, and God/Saint reclaimed it by removing all the water from the lake. The old lake deposits that surround most of the Leh valley are a testimony to this argument. Interestingly, people of Kashmir have similar views that the valley was a vast lake called Satisar, which was later drained by a saint named Kashyap Rishi (Stein, 1899). The geological studies also agree with lake stories of both these valleys. However, the formation is attributed to the tectonic collision of India with Asia, and not to some supernatural event.

CONCLUSION AND RECOMMENDATIONS

The fieldwork exercise in parts of Kashmir and Leh is part of our scientific mission to understand the level of earthquake and flood hazard related education and awareness among people. Most of the people are aware of flood hazards, but unfortunately, they continue to rebuild on dangerous flood zones. The concerned authorities in Jammu and Kashmir should thoroughly examine such practices otherwise, if left unchecked, they can lead to devastating flood disasters in the future. The earthquake hazards are less of a concern to people in Leh and Kashmir, and this is possible because of the prolonged recurrence interval of a devastating earthquake event in the recent history of Jammu and Kashmir region. The people are not aware of how to build an earthquake resistant house or any such buildings. The unstable political condition of Kashmir region is one of the primary reasons that people are not really interested in developing earthquake and flood hazard safety measures, which gets gloomy with some religious and cultural perceptions. Undoubtedly, the political dispute is of primary importance to people in Kashmir, and everything else is secondary. Although scientific progress can significantly help one to understand the science and remedy of how to live with hazards, such progress ought to be achieved on the political front as well so that people can feel a sense of safety and security. There is an urgent need to engage local communities in the building of a resilient community culture to deal with earthquake and flood hazards. International scholarship programs can significantly narrow the knowledge gap by helping local scientists to handle such hazards. International workshop and conferences can also aid in highlighting the scientific and political problems that the region faces and could assist in resolving such issues.

ETHICS STATEMENT

The Ethics Committee of the Faculty of Arts and Social Sciences, University of Brunei Darussalam in a meeting held on May 1, 2018 reviewed and approved the fieldwork involving subjects in Jammu and Kashmir, India. Under the registration no. 17H0553. The person involved is Sheeba Khwaja, one of the authors of this paper.

AUTHOR CONTRIBUTIONS

AS and SK coordinated the work and planned the outline of the manuscript. QR and ZJ mainly contributed to field data collection. AS wrote the earthquake and flood-related portions of the manuscript. SK and BS wrote the historical context of the Kashmir problem. BS have contributed significantly to the English language editing of the paper. All authors discussed the results and contributed to the writing of the manuscript.

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REFERENCES

Afzal, M. R. (ed.) (1966). *Speeches and Statements of the Quaid-i-Azam Mohammad Ali Jinnah, 1911–36 and 1947–48*. Lahore: Research Society of Pakistan.

Alexander, D. E. (2007). Misconception as a barrier to teaching about disasters. *Prehosp. Disaster Med.* 22, 95–103. doi: 10.1017/S1049023X00004441

Ali, U., and Ali, S. A. (2018). Seismically induced soft-sediment deformation structures in an active seismogenic setting: the plio-pleistocene karewa deposits, Kashmir Basin (NW Himalaya). *J. Struct. Geol.* 115, 28–46. doi: 10.1016/j.jsg.2018.07.005

Ambraseys, N., and Bilham, R. (2000). A note on the Kangra M s = 7.8 earthquake of 4 April 1905. *Curr. Sci.* 79, 45–50.

Ambraseys, N., and Bilham, R. (2011). Corruption kills. *Nature* 469, 153–155. doi: 10.1038/469153a

Ambraseys, N. N., and Douglas, J. (2004). Magnitude calibration of north Indian earthquakes. *Geophy. J. Int.* 159, 165–206. doi: 10.1111/j.1365-246X.2004.02323.x

Avouac, J. P., Meng, L., Wei, S., Wang, T., and Ampuero, J. P. (2015). Lower edge of locked main Himalayan thrust unzipped by the 2015 Gorkha earthquake. *Nat. Geosci.* 8, 708–711. doi: 10.1038/ngeo2518

Bendick, R., Bilham, R., Fielding, E., Gaur, V. K., Hough, S. E., Kier, G., and Mukul, M. (2001). The 26 January 2001 "Republic Day" earthquake, India. *Seismol. Res. Lett.* 72, 328–335.

Bhatt, D. K. (1976). Stratigraphical status of karewa group of Kashmir. *India Himalayan Geol.* 6, 197–208.

Bilham, R., and Bali, B. S. (2014). A ninth century earthquake-induced landslide and fl ood in the Kashmir Valley, and earthquake damage to Kashmir's medieval temples: bull. *Earthq. Eng.* 12, 79–109. doi: 10.1007/s10518-013-9504-x

Bilham, R., Gaur, V. K., and Molnar, P. (2001). Himalayan seismic hazard. *Science* 293, 1442–1444. doi: 10.1126/science.1062584

Bilham, R., Singh, B., Bhat, I., and Hough, S. (2010). Historical earthquakes in Srinagar, Kashmir: clues from the shiva temple at pandrethan. *Spec. Pap. Geol. Soc. Am.* 471, 107–117. doi: 10.1130/2010.2471(10)

Bose, S. (1997). *The Challenge in Kashmir*. Michigan, IN: University of Michigan Democracy Press.

Brass, P. R. (2003). The partition of India and retributive genocide in the Punjab, 1946-47: means, methods, and purposes. *J. Genoc. Res.* 5, 71–101. doi: 10.1080/14623520305657

Burbank, D. W., and Johnson, G. D. (1982). Intermontane-basin development in the past 4 Myr in the north-west Himalaya. *Nature* 298, 432–436. doi: 10.1038/298432a0

Burbank, D. W., and Johnson, G. D. (1983). The Late Cenozoic chronologic and stratigraphic development of the Kashmir intermontane basin, northwestern Himalaya. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 43, 205–235. doi: 10.1016/0031-0182(83)90012-3

Chandra, R., Dar, J. A., Romshoo, S. A., Rashid, I., Parvez, I. A., Mir, S. A., et al. (2018). Seismic hazard and probability assessment of Kashmir valley, northwest Himalaya. *India Nat. Hazards* 93, 1451–1477. doi: 10.1007/s11069-018-3362-4

Ding, L., Kapp, P., and Wan, X. (2005). Paleocene–eocene record of ophiolite obduction and initial India-Asia collision, South central Tibet. *Tectonics* 24:TC3001. doi: 10.1029/2004TC001729

Copley, A., Avouac, J. P., and Royer, J. Y. (2010). India-Asia collision and the Cenozoic slowdown of the Indian plate: implications for the forces driving plate motions. *J. Geophy. Res.* 115:B03410. doi: 10.1029/2009JB006634

Crowley, K., and Elliott, J. R. (2012). Earthquake disasters and resilience in the global North: lessons from New Zealand and Japan. *Geograph. J.* 178, 208–215. doi: 10.1111/j.1475-4959.2011.00453.x

Ellis, P., and Khan, J. (1999). "Kashmir: partition and the diaspora," in *Region and Partition: Bengal, Punjab and the Partition of the Subcontinent*, ed. G. Singh (New Delhi: Oxford University Press).

Fazili, M. (1980). *Socialist Ideas and Movements in Kashmir (1919-1947)*. New Delhi: Eureka Publications.

Gavillot, Y., Meigs, A., Yule, D., Heermance, R., Rittenour, T., Madugo, C., et al. (2016). Shortening rate and Holocene surface rupture on the Riasi fault system in the Kashmir Himalaya: active thrusting within the Northwest Himalayan orogenic wedge. *Geol. Soc. Am. Bull.* 128, 1070–1094. doi: 10.1130/B31281.1

Gilmartin, D. (1998). Partition, Pakistan, and South Asian history: in search of a narrative. *J. Asian Stud.* 57, 1068–1095. doi: 10.2307/2659304

Hobley, D. E., Sinclair, H. D., and Mudd, S. M. (2012). Reconstruction of a major storm event from its geomorphic signature: the Ladakh floods, 6 August 2010. *Geology* 40, 483–486. doi: 10.1130/G32935.1

Hough, S. E. (2010). *Predicting the Unpredictable: The Tumultuous Science of Earthquake Prediction*, Vol. 272, Princeton: Princeton University Press. doi: 10.1515/9781400883547

Islam, N. (1981). Islam and national identity: the case of Pakistan and Bangla Desh. *Int. J. Middle East Stud.* 13, 55–72. doi: 10.1017/S0020743800055070

Jalal, A. (1990). Kashmir Scars: A Terrible Beauty is Torn. *New Repub.* 17–20.

Kirstein, L. A. (2011). Thermal evolution and exhumation of the Ladakh Batholith, northwest Himalaya. *India Tectonophys.* 503, 222–233. doi: 10.1016/j.tecto.2011.03.005

Kumar, R., and Acharya, P. (2016). Flood hazard and risk assessment of 2014 floods in Kashmir valley: a space-based multisensor approach. *Nat. Hazards* 84, 437–464. doi: 10.1007/s11069-016-2428-4

Kumar, S., Wesnousky, S. G., Rockwell, T. K., Ragona, D., Thakur, V. C., and Seitz, G. G. (2001). Earthquake recurrence and rupture dynamics of Himalayan frontal Thrust. India. *Science* 294, 2328–2331. doi: 10.1126/science.1066195

Lawrence, W. R. (1895). *The Valley of Kashmir*. Oxford: Oxford University Press, 205–219.

Le Fort, P. (1975). Himalayas: the collided range. Present knowledge of the continental arc. *Am. J. Sci.* 275, 1–44.

Meraj, G., Romshoo, S. A., Yousuf, A. R., Altaf, S., and Altaf, F. (2015). Assessing the influence of watershed characteristics on the flood vulnerability of Jhelum basin in Kashmir Himalaya. *Nat. Hazards* 77, 153–175. doi: 10.1007/s11069-015-1605-1

Najman, Y., Appel, E., Boudagher-Fadel, M., Bown, P., Carter, A., Garzanti, E., et al. (2010). Timing of India-Asia collision: geological, biostratigraphic, and palaeomagnetic constraints. *J. Geophys. Res.* 115:B12416. doi: 10.1029/2010JB007673

Nakata, T. (1989). Active faults of the Himalaya of India and Nepal. *Geol. Soc. Am. Spec. Pap.* 232, 243–264. doi: 10.1130/SPE232-p243

Naseer, A., Khan, A. N., Hussain, Z., and Ali, Q. (2010). Observed seismic behavior of buildings in northern Pakistan during the 2005 Kashmir earthquake. *Earthq. Spectra* 26, 425–449. doi: 10.1193/1.3383119

Paton, D., Bajek, R., Okada, N., and McIvor, D. (2010). Predicting community earthquake preparedness: a cross-cultural comparison of Japan and New Zealand. *Nat. Hazards* 54, 765–781. doi: 10.1007/s11069-010-9500-2

Pathier, E., Fielding, E. J., Wright, T. J., Walker, R., Parsons, B. E., and Hensley, S. (2006). Displacement field and slip distribution of the 2005 Kashmir earthquake from SAR imagery. *Geophys. Res. Lett.* 33:L20310. doi: 10.1029/2006GL027193

Romshoo, S. A., Altaf, S., Rashid, I., and Dar, R. A. (2018). Climatic, geomorphic and anthropogenic drivers of the 2014 extreme flooding in the Jhelum basin of Kashmir. India. *Geomat. Nat. Hazards Risk* 9, 224–248. doi: 10.1080/19475705.2017.1417332

Schiffman, C., Singh Bali, B., Szeliga, W., and Bilham, R. (2013). Seismic slip deficit in the Kashmir Himalaya from GPS observations. *Geophy. Res. Lett.* 40, 5642–5645. doi: 10.1002/2013GL057700

Searle, M., Corfield, R. I., Stephenson, B., and McCarron, J. (1997). Structure of the North Indian continental margin in the Ladakh-Zanskar Himalayas: implications for the timing of obduction of the Spontang ophiolite, India-Asia collision and deformation events in the Himalaya. *Geol. Mag.* 134, 297–316. doi: 10.1017/S0016756897006857

Shah, A. A. (2013). Earthquake geology of Kashmir Basin and its implications for future large earthquakes. *Int. J. Earth Sci.* 102, 1957–1966. doi: 10.1007/s00531-013-0874-8

Shah, A. A. (2014). Predicting the unpredictable: the tumultuous science of earthquake prediction. *Geosci. J.* 18, 373–374. doi: 10.1007/s12303-014-0002-1

Shah, A. A. (2015). Assessing the influence of watershed characteristics on the flood vulnerability of Jhelum Basin in Kashmir Himalaya by Gowhar et al., 2015. *Nat. Hazards* 77, 2139–2143. doi: 10.1007/s11069-015-1775-x

Shah, A. A. (2016). The Kashmir Basin fault and its influence on fluvial flooding in the Kashmir Basin, NW Himalaya. *Geol. Soc. Am. Spec. Pap.* 520, 321–334. doi: 10.1130/2016.2520(28)

Shah, A. A., and Malik, J. N. (2017). Four major unknown active faults identified, using satellite data, in India and Pakistan portions of NW Himalaya. *Nat. Hazards* 88, 1845–1865. doi: 10.1007/s11069-017-2949-5

Shah, A. A., Qadri, T., and Khwaja, S. (2018). Living with earthquake hazards in South and Southeast Asia. *ASEAN J. Commun. Engage.* 2, 15–37.

Sherman, T. C. (2007). The integration of the princely state of Hyderabad and the making of the postcolonial state in India, 1948–56. *Ind. Econ. Soc. Hist. Rev.* 44, 489–516. doi: 10.1177/001946460704400404

Sieh, K. (2007). The Sunda megathrust–past, present and future. *J. Earthq. Tsunami* 1, 1–19. doi: 10.1142/S179343110700002X

Stein, A. (1899). *Memoir on Maps Illustrating the Ancient Geography of Kaśmîr*. Kolkata: Baptist Mission Society, 65–66.

St-Onge, M. R., Rayner, N., and Searle, M. P. (2010). Zircon age determinations for the Ladakh batholith at Chumatang (Northwest India): implications for the age of the India-Asia collision in the Ladakh Himalaya. *Tectonophysics* 495, 171–183. doi: 10.1016/j.tecto.2010.09.010

Subbiah, S. (2004). Security council mediation and the kashmir dispute: reflections on its failures and possibilities for renewal. *Boston College Int. Comp. Law Rev.* 27, 173–185.

Tejwani, N. C., and Immerman, I. (2008). Myths and legends in orthopaedic practice: are we all guilty? *Clin. Orthop.* 466, 2861–2872. doi: 10.1007/s11999-008-0458-2

Thayyen, R. J., Dimri, A. P., Kumar, P., and Agnihotri, G. (2013). Study of cloudburst and flash floods around Leh, India, during August 4–6, 2010. *Nat. hazards* 65, 2175–2204. doi: 10.1007/s11069-012-0464-2

Wallis, D., Carter, A., Phillips, R. J., Parsons, A. J., and Searle, M. P. (2016). Spatial variation in exhumation rates across Ladakh and the Karakoram: new apatite fission track data from the Eastern Karakoram, NW India. *Tectonics* 35, 704–721. doi: 10.1002/2015TC003943

Wani, G. A. (1995). *Kashmir: History and Politics: Annotated Bibliography*. Srinagar: G.A.Wani.

Whitehead, A. (2007). *A Mission in Kashmir*. New Delhi: Penguin Books.

Yin, A. (2006). Cenozoic tectonic evolution of the Himalayan orogen as constrained by along-strike variation of structural geometry, exhumation history, and foreland sedimentation. *Earth. Sci. Rev.* 76, 1–131. doi: 10.1016/j.earscirev.2005.05.004

Zutshi, C. (2004). *Languages of Belonging: Islam, Regional Identity and the Making of Kashmir*. London: C. Hurst & Co.

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